FAA-R-1265b
January 7, 1963

FEDERAL AVIATION AGENCY

TECHNICAL SPECIFICATION

for

Three Cavity Pulsed Amplifier Klystron, Control Grid Modulated

The requirements and tests of the latest issue of Specification MIL-E-1 shall apply, except as noted otherwise.

RATINGS

	E_f V	E_b KV	e_g V	i_b a	P_i KW	P_i W	P_d Pulse W	P_d W	P_o KW	P_o W
Absolute Maximum :	4.5	20	600	10	200	2300	500	80	25	600
Minimum :	3.8	--	---	--	---	-----	---	--	--	---
Test Cond:	4.2	12.5	365±55	--	---	1840 max.	30	--	11.5 min.	---
Notes :	Note 1	Note 2	Notes 3, 10					Note 4	Notes 5, 20	Notes 5, 20

	E_c V	P_g W	du —	t_p μsec at 10% Ampl.	Cath. Seal T. °C	Body Seal T. °C	Col-lector T. °C
Absolute Maximum :	-250	5	2.27	10	145	115	150
Minimum :	-50	--	---	--	---	---	---
Test Cond:	-125	--	---	--	---	---	---
Notes :	Note 6		Note 17	Note 10	Ref. E Fig. 1	Ref. B,C,D Fig. 1	Ref. A Fig. 1

Tuning Range for full performance -- 960 to 1215 Mc (Notes 7 and 25)

APPLICATION NOTES

Mounting Position	- Any; Note 8	
Cooling	- Forced air	
Base	- Flexible Leads	Marking
	Heater	H
	Heater-Cathode	HK
	Grid	GRID
Cathode	- Coated Unipotential	
Initial start-up	- Note 2	

SPECIFIC INFORMATION

MIL-E-1 Reference	Test	Conditions		Limits Sym.	Min.	Max.	Units
Production Tests							
4.10.8	Heater Current	E_f = 4.2 V; Note 1		I_f	30	40	A
4.10.4.1	Anode Current	E_b = 12.5 KV; E_c = -125 V; e_g = 365 V		i_b	--	4.8	A
4.10.1.1	Emission	Note 9		$\Delta i_b/i_b$	--	10	%
	Power Output	E_b = 12.5 KV; E_c = -125; e_g = 365±55; P_d = 30 W (Peak); F = 960 - 1215 M_c/sec. P_i = 1840 max, i_g = 0.7 amp (Peak) max.; Notes 4, 5, 7, and 10		P_o	11.5	--	KW
	Spectrum	F = 960 - 1215 M_c/sec; P_o = 11.5 kw min; Note 16			45	--	db
	Cutoff Voltage	E_b = 12.5 KV; I_c = 1.0 ma; e_g = o		E_c	--	-120	Volts
	Holding Period	No voltages		t	168	--	Hours
	Grid Control Characteristic	See Figure 5					
		Design Tests					
	Pulse Droop	Note 21			--	0.5	%
4.9.2	Dimensions	Figures 1, 2, and 3					

MIL-E-1 Reference	Test	Conditions	Limits Sym.	Min.	Max.	Units
4.9.5.1	Torque Test R. F. Output Connector	No voltages			200	in-lbs
4.10.14	Capacitance Grid-Cathode	Connect shell to cathode	C_{gk}	---	150	$\mu\mu$fd
		Qualification Approval Tests				
4.15.5	Ambient Temperature Operation	F = 900 & 1215 Mc/sec; T = -10 °C to + 70°C; Note 23	ΔP_o	---	0.1	db
4.9.19.6	Operation Vibration	Note 11	$\frac{\Delta V \text{ Max.}}{V \text{ Max.}}$	---	3.0	%
	Warm-up Time	Note 19 (10.5 KW P_o)	t	---	10	sec.
		Note 19 (rated P_o)	t	---	35	sec.
3.7.2	Marking	Figures 1, 2, and 3; Note 31				
4.9.18 4.9.18.1.5	Container Drop	Notes 12 and 30				
	Shock	Notes 12 and 15				
4.9.19.7	Non-operation Vibration	No voltage F = 1100; Note 18	ΔF	---	.5	Mc/sec
	Harmonic Power Output	Note 13		50	---	db
		Life Tests				
4.11.3	Life Test	E_b = 12.5 KV; P_i = 1840 W; e_g = 365 ± 55V t_p = 10 μsec; Note 14		1000	---	Hrs.
4.11.4	Life Test End Point	P_o test	P_o	10.5	---	KW
			$\Delta i_b/i_b$	---	10	%
	Spectrum	Note 16		45	---	db

Packaging Information

5.1	Packaging and Packing	Notes 22 and 32; Attachment 1

Note 1: When first applying heater voltage, the heater current shall be limited to 70 amperes. Within a 5 minute preheat period the heater current shall stabilize within the limits specified.

Note 2: E_b is a D.C. voltage applied to the cathode negative with respect to the tube body. This procedure to be followed for all new tubes and tubes which have not been operated during the preceding three month period.

a. Turn off main power and rearrange the main power transformer from delta to wye input connection.

b. Reduce the grid drive voltage to zero (do not change the bias voltage from its normal -125 V setting).

c. Disconnect the R.F. drive at the input BNC jack on the klystron.

d. Turn on main power and apply rated filament voltage for 15 minutes.

e. Apply the reduced beam voltage (approximately 7 KV from Step a above) for 15 minutes.

f. Increase the grid drive from zero to a value which gives 10 ma. of average beam current.

g. Increase the grid drive for an additional 10 ma. of average beam current every five minutes until 50 ma. of beam current is reached. Operate at 50 ma. beam current for five minutes.

h. Reduce the beam voltage and the grid drive to zero, turn off main power and reconnect the power transformer in its original delta setting.

i. Turn on main power, apply the rated beam voltage and increase the grid drive to give 60 ma. average beam current. Continue to increase the grid drive to values which provide 10 ma. beam current increases every five minutes until the current reaches 90 ma. and operates at 90 ma. for five minutes.

j. Reduce beam voltage and grid drive to zero and reconnect R.F. drive.

The tube is now considered to be properly aged and ready to be placed into service.

R.F. drive may be applied at any time during the start-up procedure. The output of the d.c. beam supply shall be followed by a series resistor of approximately 10 ohms to prevent serious surges of beam current through the tube.

Note 3: The control grid shall be driven with a shaped pulse pair (Note 10) which has a peak amplitude as specified with reference to the negative bias voltage (total grid swing).

Note 4: The R.F. drive is applied to the input resonator of the tube. The R. F. drive may be either pulsed of c.w. When a rectangular pulse drive is used, synchronization must be provided to allow the control grid pulse to appear in time phase with the R.F. pulse. The R.F. drive pulse must be free from frequency modulation which would prevent testing the klystrons to the performance limits indicated.

Note 5: The tube shall deliver the specified rated power into a transformer adjusted load in accordance with Attachment 2. A load which presents a VSWR of 1.5-1 or less shall be considered an equivalent load for production test purposes only.

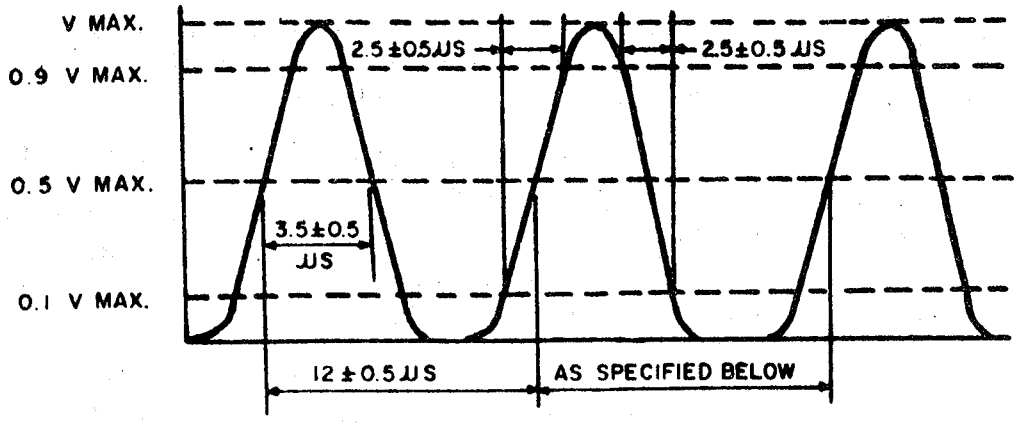
Note 6: With beam voltage applied the klystron must not be operated without negative grid bias. Overload circuits must be included in the HV power circuits to remove beam voltage from the klystron upon the loss of bias. Tube damage shall not occur if automatic reset equipment simultaneously reapplies E_b, E_c, and e_g to a tube (within 2 seconds after a power supply interruption) up to 4 resets within a 12 second period.

Note 7: A tuning curve shall be supplied with each tube. The frequency of each resonator can be set approximately by adjusting the tuning ring spacing of each resonator according to the tuning charts. Tuning rings shall be parallel within two turns of a tuning nut after final adjustment. When adjusted to any operating frequency in the range from 960 to 1215 mc in accordance with the individual cold tuning charts and when supplied with R.F. drive over the range of nominal frequency $\pm$ 0.5 mc, the klystron shall deliver a minimum R. F. output power of 30 watts into a 50 ohm resistive load.

Note 8: The klystron shall be designed for mounting in any position using the four 3/8" threaded inserts on the Collector End Plate (see Figure 2) and a suitable strap around the 5-3/8" diameter as shown in Figure 1.

Note 9: Under conditions in Anode Current Test 4.10.4.1, the filament voltage is decreased from 4.5 V to 3.8 V. The percentage change in anode current shall be within the specified limit.

Note 10: a. The e_g pulse shall be of such shape as to provide R.F. output voltages which conform to the following diagram:



b. The e_g pulses shall be composed of pairs spaced 12.0 ± .5 microseconds between centers. The repetition rate shall be 3783 pairs per second.

c. The tube shall not oscillate with the input line disconnected and the input and output resonators tuned to the same frequency provided that the middle resonator is detuned by one turn of one tuning nut from resonance.

d. The current characteristics of the control grid shall have the form shown in Fig. 5 and the values shall fall between the limits shown. The output of the grid modulator shall be loaded with a shunt resistance of 500 ohms or less.

e. After account has been taken of existing differences in the amplitude of adjoining e_g pulses, and correction made for the 5/4 power relationship between the output voltage pulse amplitude and droop in E_b, there shall be no more than 0.5% difference in the amplitudes of the two pulses of any pair.

Note 11: The tube shall be operated under the test conditions as specified herein and shall be vibrated at 15 and 135 cps in a horizontal plane. The force applied to the tube shall be 2.5 g. The percent amplitude modulation of the R.F. output voltage pulse shall be within the specified limits.

Note 12: After Container Drop and/or Shock test, power output shall be within the limits specified.

Note 13: The second harmonic of the fundamental drive frequency shall be below the limit specified herein when the output of the klystron is examined under p_o conditions by spectrum analyzer techniques at the R.F. drive frequencies of 960, 1100, and 1215 Mc per second.

Note 14: Down periods shall be 0, 24, 48, 100, 250, and 500 hours. The beam current shall be measured at each down period. Power output shall be measured only at 0, 48, 250 and 500 hours. During life test the klystron shall be operated under the following conditions:

E_b = 12.5 KV
P_i = 1840 W
e_g = 365±55
t_p = 10 μsec (rectangular)

Average power may be adjusted by means of variable pulse repetition rate and grid voltage.

Note 15: a. Shock Equipment: The standard Navy High Impact Shock Tester Machine for lightweight equipment (BuShips plan 10-T-2145-L) or Barry Corporation Medium Impact Shock Machine Type 150-400 VD (MIL-S-4454, USAF) shall be used.

b. Mounting: The tube shall be mounted in a shock-mounted rack, resonant at 35±5 cps at normal vibration amplitude (less than .100 displacement). This platform shall exhibit these frequency characteristics in all directions of applied shock. The deflection characteristics of this shock-mounted rack shall be the same as or similar to that of Barry Corporation Shock Mounts, Type C-2080-T6-SB.

c. Direction of Shock: The directions shall be X_1, X_2, and Y_2 as defined in MIL-E-1, reference 3.9.1.

d. Amplitude of Shock: The shock on the Navy high impact machine for lightweight equipment shall consist of three hammer blows in each of the three specified directions from a height of three feet. The shock on the Barry Corporation Shock Machine, or equivalent, shall consist of three 15 inch drops of the carriage with the tube mounted in each of the three specified directions. The twelve block configuration shall be used.

Note 16: With (1) a grid drive pulse within the limits defined in Figure 4
(2) an output voltage pulse of 4.0 μsec maximum when measured at half amplitude,
(3) a peak drive voltage set at a point in the range 365±55 volts with

reference to the bias level of -125 volts d.c., (4) the input and center cavities suitably detuned as described below and (5) a peak power output of at least 11.5 KW, the following spectrum requirement will be met:

The frequency spectrum of the output R.F. pulses shall be such that the energy in each 500 KC wide band, centered ±800 KC from the center frequency shall be greater than 45 db down from the energy in the 500 KC band centered on the carrier frequency; further, the energy in each 500 KC wide band, centered ± 2 Mc from the center frequency shall be greater than 55 db down from the energy in the 500 KC band centered on the carrier frequency. Each lobe of the spectrum shall be of less amplitude than the adjacent lobe nearer the center frequency.

For the purpose of conducting the spectrum check, the following procedure is observed:

a. Place tube in circuit and apply the warm up voltages as described in Notes 1 and 2.

b. When the specified beam current (see Figure 6 for shape) has been applied and the tube has been delivering rated power for a period of at least 10 min., the R.F. exciter and input cavity are tuned for the maximum absorption of available power from the exciter at the time when the video grid drive pulse is at its peak.

c. While viewing the center cavity monitor, adjust the center cavity for maximum amplitude of detected R.F. pulse at this point.

d. Adjust the output cavity and load adjusting transformer for maximum power output to the matched load.

e. Tune the input cavity observing that the output power peaks, dips and peaks as the cavity is tuned in one direction. Tune to the dip. Tune the center cavity to obtain the maximum power output (this places the center cavity above synchronous frequency). (Upon return to the input cavity, it will now be noted that there is only one peak in the power output.)

f. Make minor adjustments to the output cavity for maximum output.

g. Recheck the R.F. input drive for maximum power transfer.

h. Adjust center cavity tuning to give proper R.F. detected output voltage wave shape.

i. The tube is now checked for spectrum and the energy ratios defined above shall be observed. If the required spectrum is not obtained, repeat Steps b through h and again check spectrum.*

If again the required spectrum is not obtained, reduce grid video drive to that value required to produce 11.5 KW output power and repeat Steps b through h.* Observe the spectrum for rated characteristics as defined herein.

The tube shall now simultaneously provide minimum power output and spectrum requirements in accordance with this specification.

*Note: In no case shall repeating Steps b through h include readjustment of the klystron output cavity.

Note 17: The duty cycle is computed from the R.F. output power pulse, and is averaged over a period of one second.

Note 18: This is a mechanical test only. The resonant frequency of each resonator shall be set at 1100 ± 2 Mc/sec by "cold test" methods. After vibration, the cold resonant frequency of the respective resonators shall be within the limits specified herein of the original setting. The frequency of the vibrating table shall be 25 ± 2 cps. Acceleration shall not exceed 2.5 g.

Note 19: With the heater voltage applied for at least five minutes, the klystron will meet minimum power output requirements within the specified time after e_g and E_b are applied simultaneously.

Note 20: No damage to the tube or output coupling shall occur if the tube output connector is open or short-circuited or terminated in any resistance or reactance or combination thereof between the limits of open- and short-circuit, when used in TACAN beacon equipment types bearing the nomenclature AN/GRN-9A, -9B or -9C and when the klystron is tuned in these equipments in accordance with instructions contained in Attachment 2 hereto.

No damage to the tube shall occur from applied voltage variations of ± 30% for one second or ± 20% for five seconds. Filaments shall not be damaged with voltage variations of ± 15%.

Note 21: After account has been taken of existing differences in the amplitude of adjoining e_g pulses, and correction made for the 5/4 power relationship between the output voltage pulse amplitude and droop in E_b, there shall be in addition no more than 0.5% difference between the maximum amplitude pulse and the minimum amplitude pulse in a group of 24 successive pulses; these 24 pulses to be evenly spaced 12 microseconds apart.

Note 22: With the tube operating as in power output test, removal of grid pulse voltage shall reduce the R.F. output to 5 microwatts maximum. The level of R.F. output for any condition of tuning in the absence of beam current shall be at least 80 db below the R.F. excitation.

Note 23: The tube shall meet minimum (11.5 KW) power and spectrum specifications (-45 db) over a $\pm$ 20°C temperature range without retuning. The tube shall meet the indicated drift of -0.1, +0.5 db in peak power output and provide a minimum spectrum of -44 db throughout the temperature range corresponding to a cabinet temperature of -10°C through +70°C without retuning.

Note 24: The tube shall be capable of tuning without damage over the frequency range of 957 mc through 1218 mc.

Note 25: No magnetic field shall be required to operate the tube and meet these specifications.

Note 26: This specification applies in all respects from sea level to 10,000 feet altitude.

Note 27: Insulation at output fittings shall withstand without failure 1.6 times rated output power (11.5 KW).

Note 28: The klystron shall be capable of continuous operation at lower powers to a minimum of 2.0 KW by reducing the grid drive voltage (e_g) only. With some retuning, the tube shall meet all the requirements of this specification except for the lower power output.

Note 29: The control grid modulator will be capable of producing wave forms within the limits specified by Figure 4.

Note 30: Not required for qualification approval of the product.

Note 31: Tubes shall be marked with the manufacturer's name and type number at the points indicated on Figure 1.

Note 32: The klystron shall be individually packaged and packed in accordance with Attachment 1 hereto.

Note 33: Figures 1 and 3: The employment of a getter to remove traces of free-gas within the klystron is optional with the tube supplier. In the event that gettering is <u>not</u> employed, the getter cap and connector may be deleted from the body of the tube. The getter cap is shown in Figures 1 and 3 as follows:

Figure 1 - Knurled cap on the depicted longitudinal axis of the tube located near cathode end.

Figure 3 - At top of figure, on vertical centerline of figure; 90 degrees clockwise from output connector.

Attachments - 3

KLYSTRON OUTLINE DRAWING

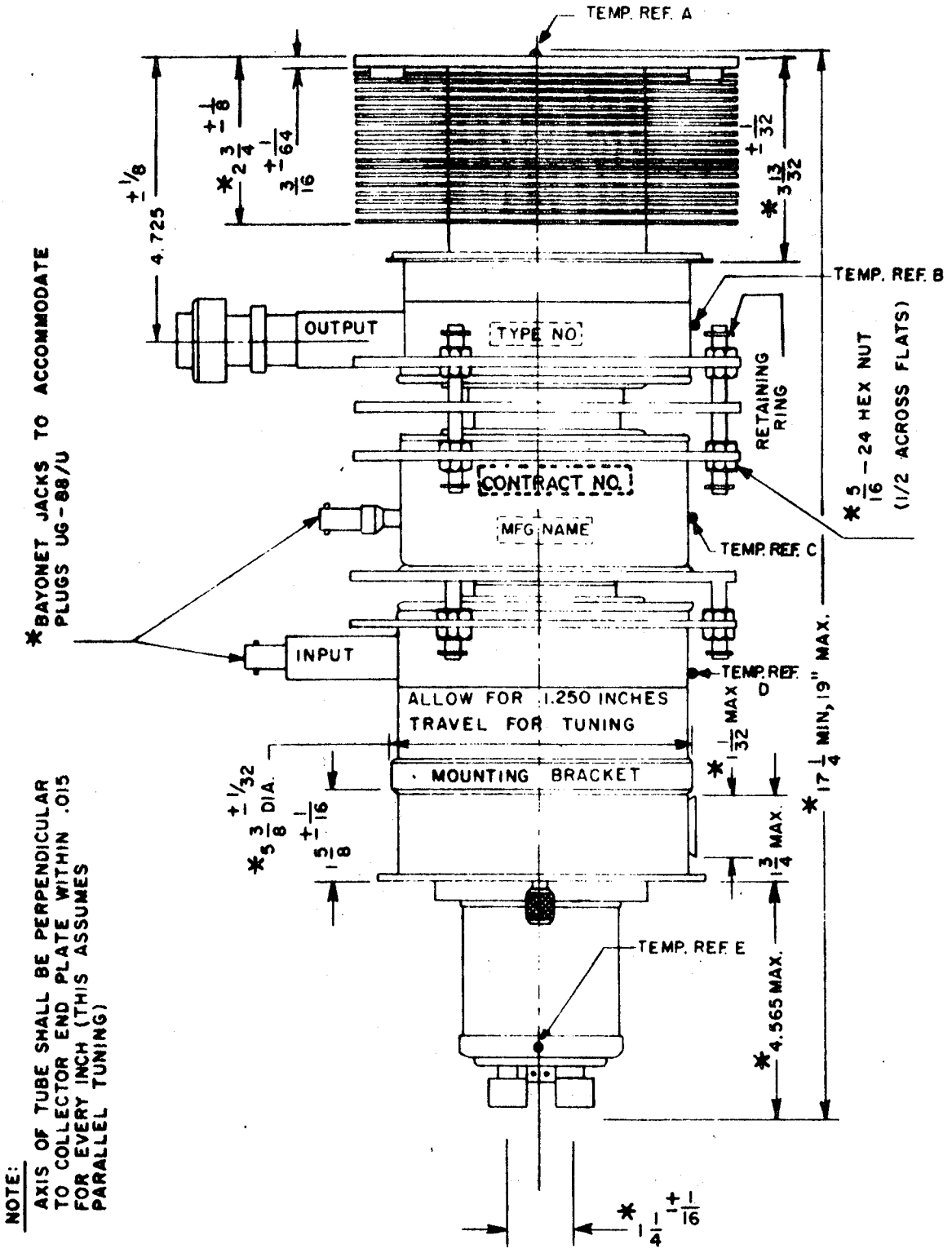


FIGURE 1

SK-A-50463-1B

KLYSTRON COLLECTOR END PLATE

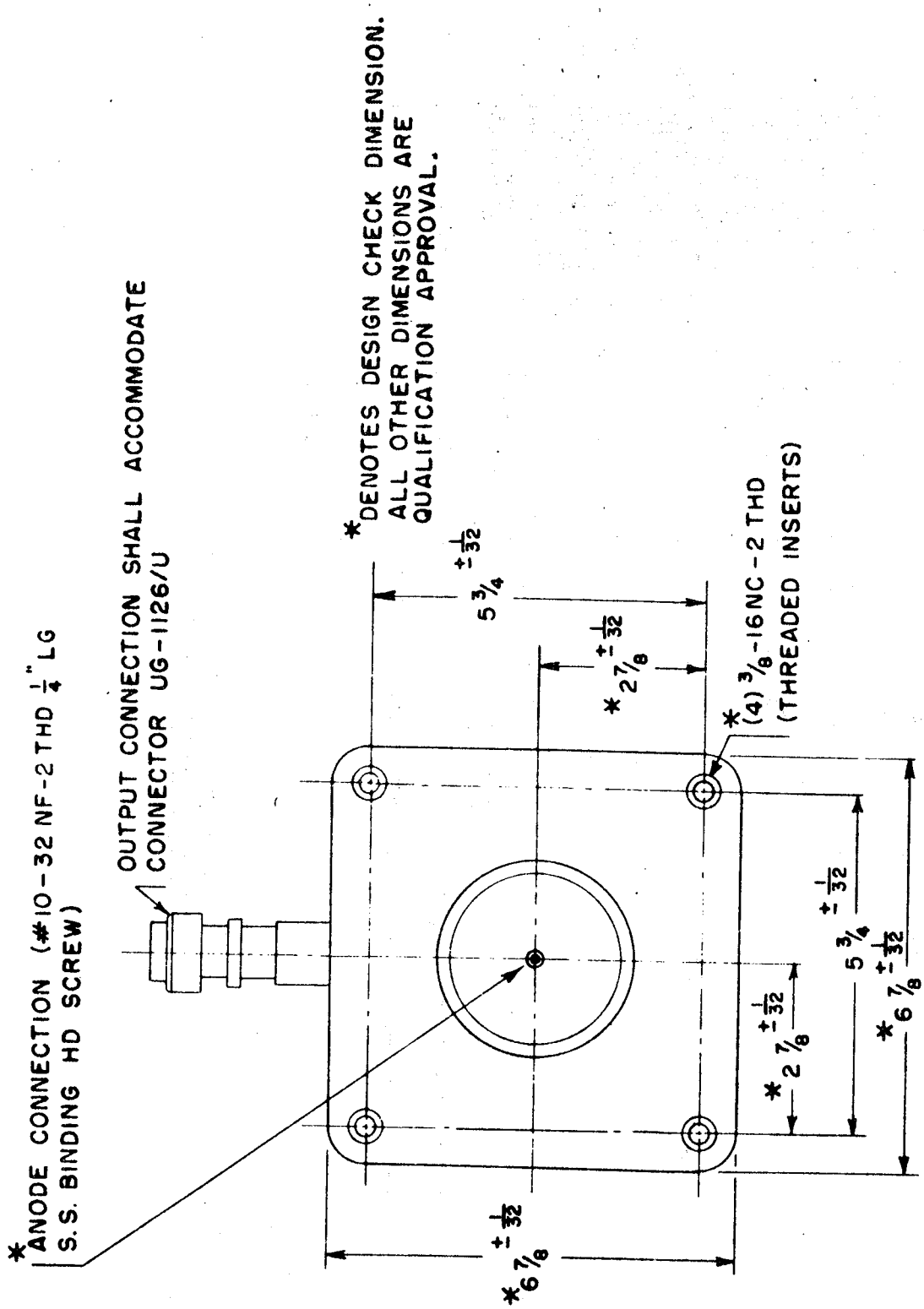
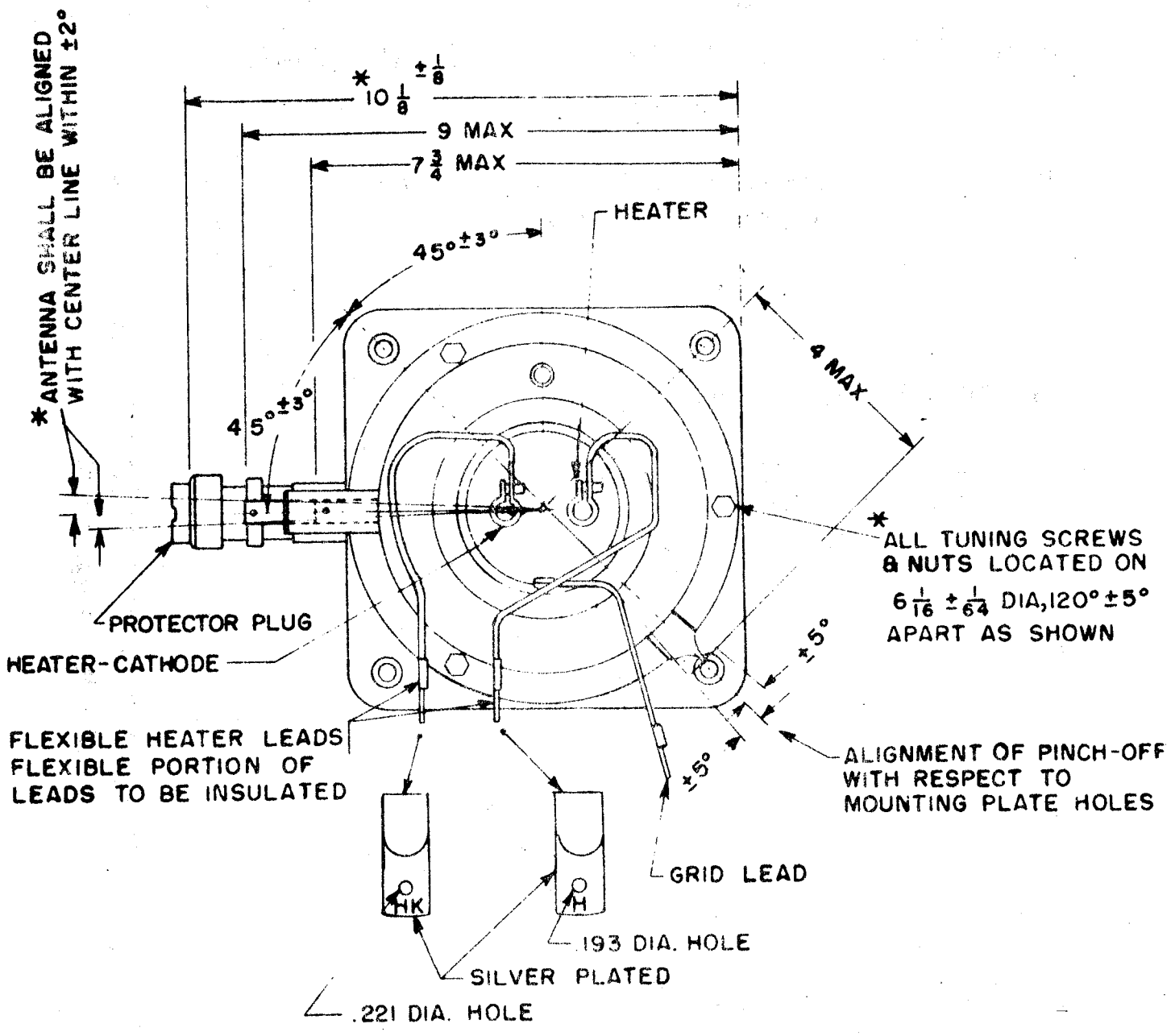


FIGURE 2

SK-A-50463-2B

KLYSTRON CATHODE END



* DENOTES DESIGN CHECK DIMENSION ALL OTHER DIMENSIONS ARE QUALIFICATION APPROVAL

FIGURE 3

SAL 89A

RANGE OF MODULATOR OUTPUT VOLTAGE (GRID DRIVE)

FOR RF OUTPUT PULSE OF 4.0 μ SEC WIDTH & PEAK POWER OF 2-11.5 KW

A-B OPERATING RANGE

C- NON-CONDUCTING REGION THE EXACT SHAPE OF WHICH IS NOT CRITICAL

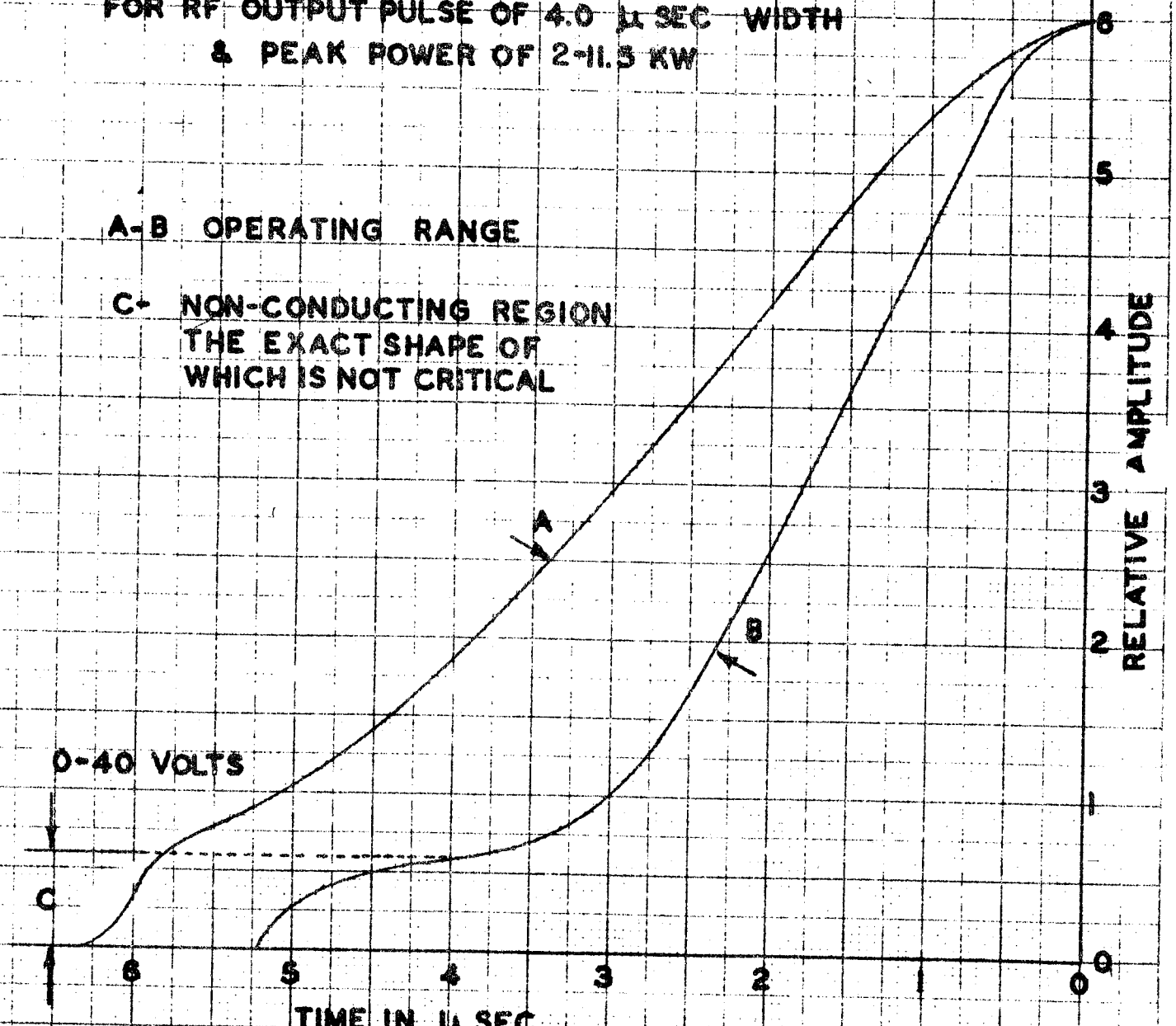
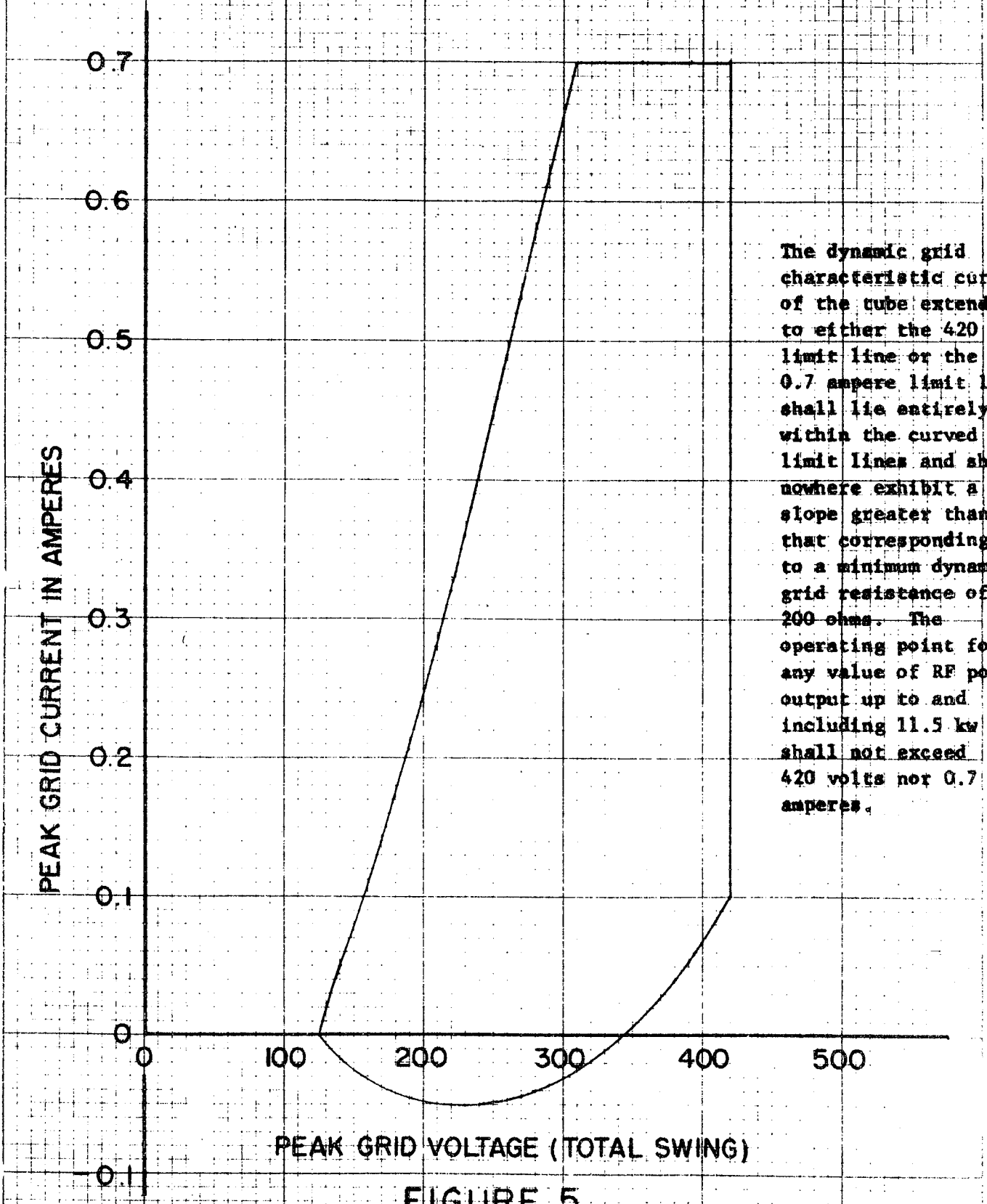


FIGURE 4

SK-A-50463-4B

SAL 89A

RANGE OF DYNAMIC CURRENT CHARACTERISTICS FOR CONTROL GRID



The dynamic grid characteristic curve of the tube extended to either the 420 volt limit line or the 0.7 ampere limit line shall lie entirely within the curved limit lines and shall nowhere exhibit a slope greater than that corresponding to a minimum dynamic grid resistance of 200 ohms. The operating point for any value of RF power output up to and including 11.5 kw shall not exceed 420 volts nor 0.7 amperes.

FIGURE 5

SK-A-50463-5B

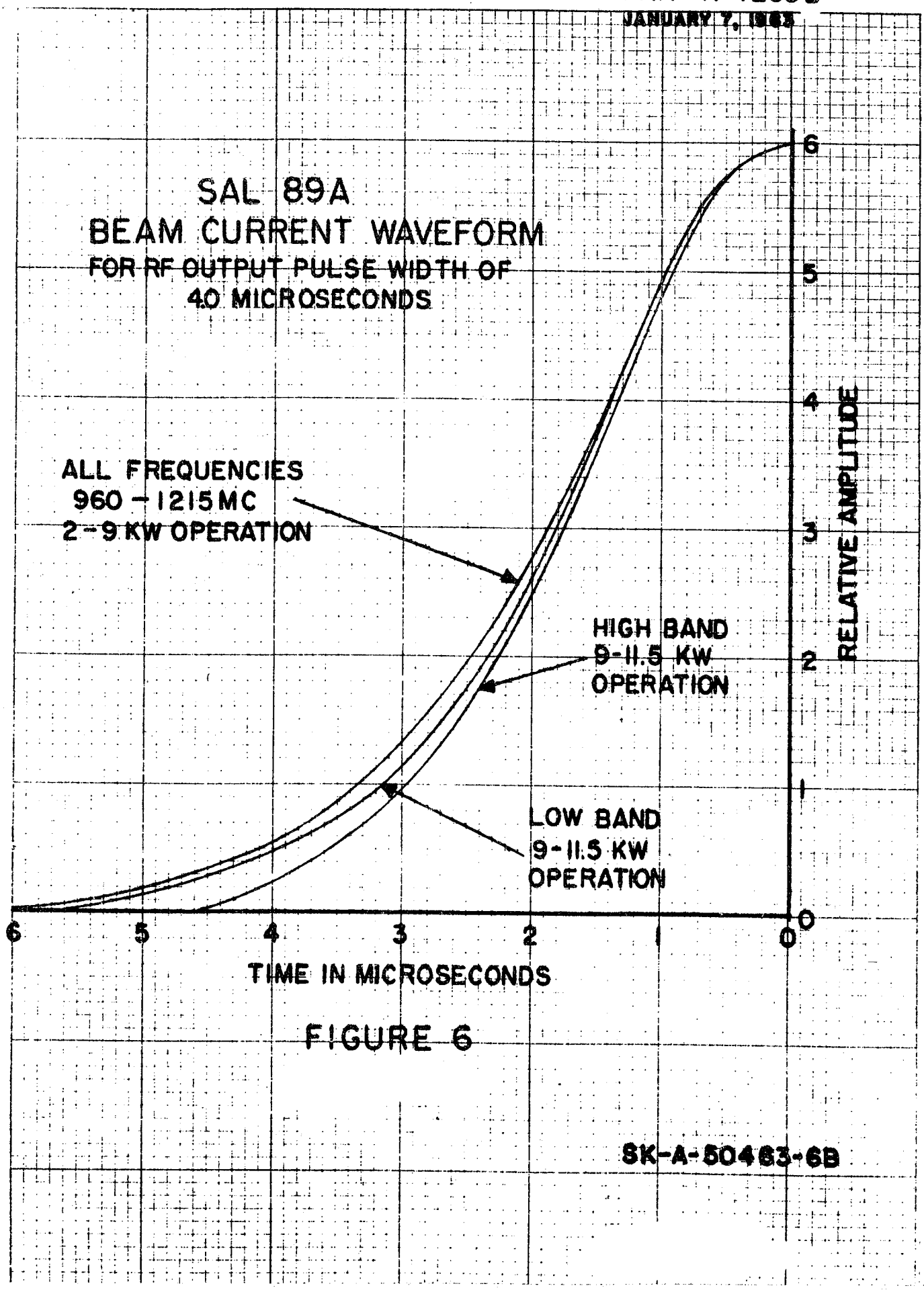

SAL 89A
BEAM CURRENT WAVEFORM
FOR RF OUTPUT PULSE WIDTH OF
40 MICROSECONDS
ALL FREQUENCIES
960 - 1215 MC
2 - 9 KW OPERATION
HIGH BAND
9 - 11.5 KW
OPERATION
LOW BAND
9 - 11.5 KW
OPERATION
RELATIVE AMPLITUDE
0
1
2
3
4
5
6
TIME IN MICROSECONDS
6
5
4
3
2
1
0
SK-A-50463-6B

FIGURE 6

TITLE: Packaging Instructions for SAL-89 Tube.

Purpose: The purpose of this specification is to establish and record the packaging procedure to be used on the subject tube to assure safe delivery to the consignee and compliance with the required military specifications.

General Practice: All vendors supplying packaging materials listed in this specification, shall submit certification of compliance to military specifications when required by this specification or the FAA drawing for such materials

BILL OR MATERIAL

Drawing	Description	Quantity
SK-A-50672-1b SK-A-50672-2b	Moulded Hair Inner Pack	1
SK-A-50671b	Metal Shipping Container	1
	Tape, Pressure Sensitive, Adhesive, Waterproof; JAN-P-127, Type I, Grade A or PPP-T-60, Type I, Class I (3" wide); Color, Black or O.D.	11 feet
	Lead & Wire Seal, American Lead-Casting Co., Brooklyn, N.Y.	1

OPERATION:

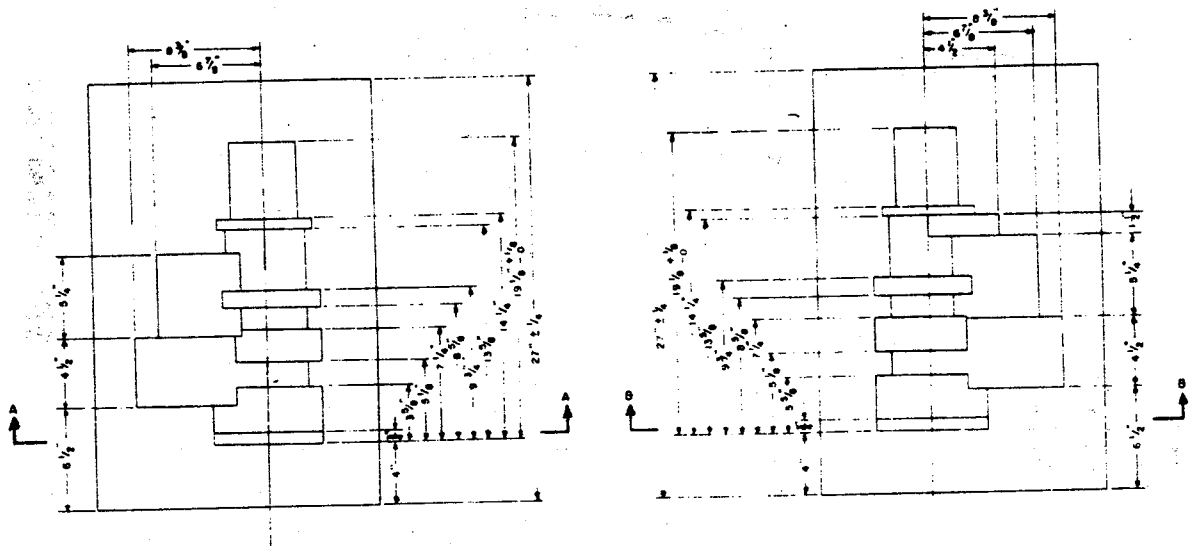
1. Position tube in one half of inner pack making sure output connector is parallel with flat surface of pack.
2. Position other half of inner pack seating firmly.
3. Tape around diameter of inner pack twice (approximately 4" in from each end) tight enough to put under slight compression.
4. Position inner packed unit in metal shipping container.
5. Position lid, gasket, and clamp ring on container.
6. Tighten clamp ring bolt securely.

NOTE: Tap all around clamp ring with soft hammer while tightening bolt to insure even fit.

7. Seal container clamp ring.

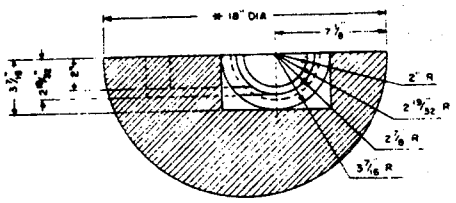
8. Label and mark per MIL-129B or contract requirements.

Attachments - 3



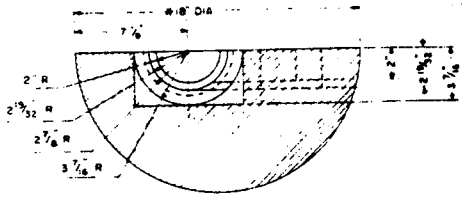
MATERIAL:
MOULDED RUBBERIZED HAIR CUSHIONING MATERIAL

DENSITY:
DENSITY OF MATERIAL TO BE DETERMINED BY WEIGHT; RANGE FROM 9 LB 12 OZ. TO 11 LB 4 OZ. NET WEIGHT FOR INNER PACK. ANY VISIBLE ABSENCE OF LATEX OR ANY VISIBLE MATERIAL SEPARATION IN AREA OF INNER CAVITY SHALL BE CAUSE FOR REJECTION.



SECTION A-A

* NOTE
18" DIA. PERMITTED TO BE OUT OF ROUND TO 1" CIRCUMFERENCE TO BE 56 9/16 ± 3/8.



SECTION B-B

MOULDED HAIR INNER PACK FOR SAL-89 TUBE

SK-A-50671-1B

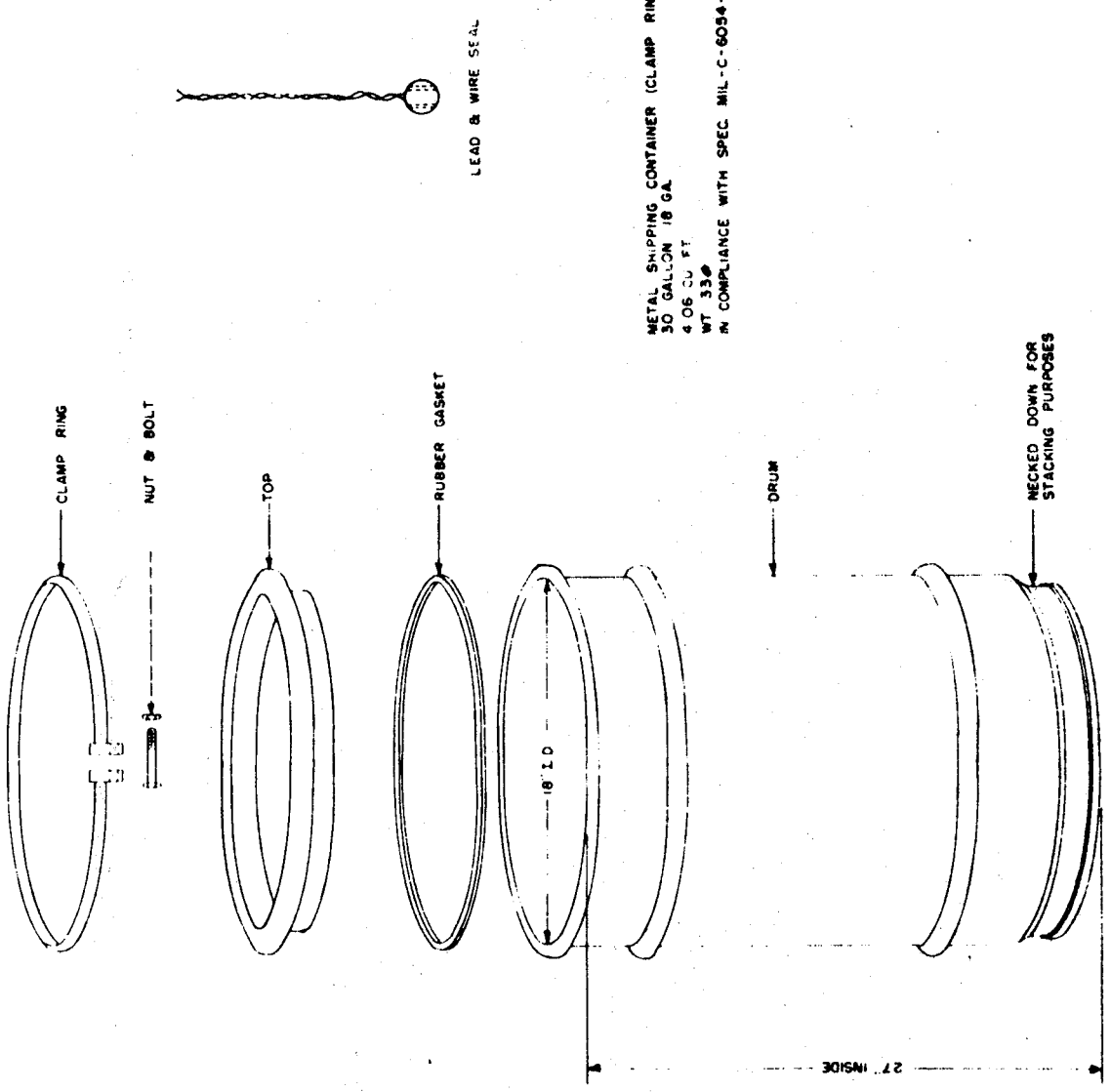
SK-A-50671-1B

FAA-R-1808B
ATTACHMENT 1
JANUARY 7, 1963

FAA-R-1265 B
ATTACHMENT 1
JANUARY 7, 1963

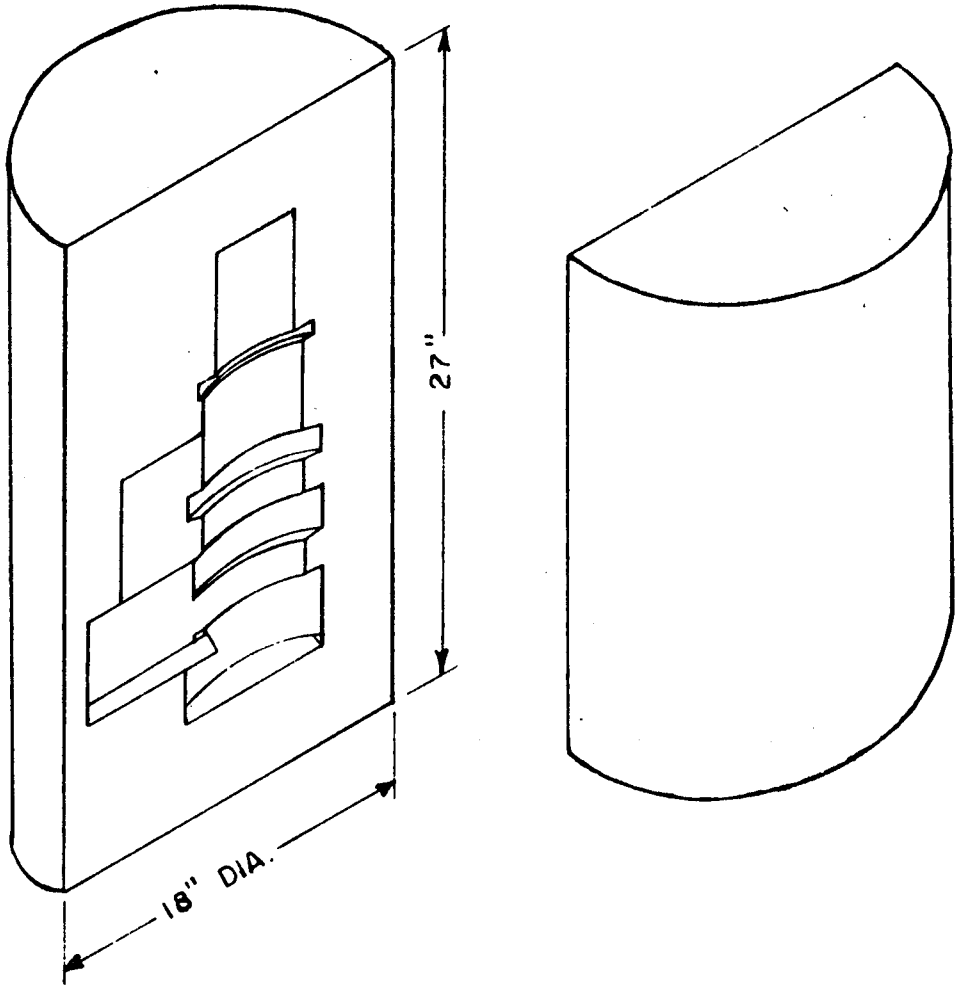
SK-A-50672 B

METAL SHIPPING CONTAINER



SK-A-50672 B

FAA-R-1265B
ATTACHMENT I
JANUARY 7, 1963



MOULDED HAIR INNER PACK FOR SAL-89 TUBE

SK-A-50671-2B

FEDERAL AVIATION AGENCY
Washington 25, D. C.

August 1, 1961

ELECTRONIC FACILITY INSTRUCTION, TACAN-8
REVISION NO. 1

TO : Chief, Facilities and Materiel Field Division Nos. 1-4
Regional Manager, Alaskan and Hawaiian Regions
ATTENTION: Chief, Facilities and Materiel Field Division Nos. 5-6

FROM : Chief, Distance Aids Section, AF-356

SUBJECT: Aging and Tuning Procedure for the Type SAL-89 Klystron Used In Type AN/GRN-9A, -9B and -9C TACAN Beacon Equipments

This Revision is a complete re-issue of the Aging and Tuning Procedure for the Type SAL-89 Klystron, and supersedes in its entirety EFI, TACAN-8 dated March 21, 1960, copies of which should be removed from the files and destroyed. Changes incorporated include:

1. Use of the delta-wye switch for aging. (All stations, after performance of EEM No. 498)

2. A new procedure suggested by the Western Region for matching the FMO RF amplifier and the klystron input cavity. (All stations)

3. The special cable procedure of EFI, TACAN-15 for final tuning of the klystron output cavity by terminating it into the Model RTC-1 TMC dummy load. (Model RTC-1 stations only)

This instruction outlines the definitive method for aging and tuning the Type SAL-89 Klystron in TACAN Beacon equipments. All previously issued and conflicting instruction on this subject are superseded and rescinded hereby.

Equipment Required:

1. Multimeter, Triplett Model 630A or equivalent

2. Inside Micrometer Calipers, Starrett Model 700A or equivalent

3. Oscilloscope, Hewlett-Packard Model 150A or equivalent

4. Crystal Detector (as furnished with beacons)

5. UG-274/U Connector (BNC Tee)

6. MX-554/U Termination, 50-ohm BNC (procure as required)

7. Patch Cable, approximately 10 ft. RG-58/U cable with UG-88/U connector at each end

8. Termaline Coaxial Resistor, 50 or 80 watt (from VORTAC working equipment)

9. Coaxial Adapter

   a. UG-201A/U (if Item 8 has type N input fitting) NSC #207-0217.00
   b. UG-309/U (if Item 8 has type HN input fitting) NSC #207-0220.00

* 10. Copy of EFI, TACAN-15

* 11. EFI, TACAN-15 Special Cable Assembly, NSC #00-0080.00

* Equipment required at TACAN facilities equipped with the Model RTC-1 TMC equipment.

The following procedures presuppose that R1420 in the Type AN/GRN-9A and -9B Beacons has been set and locked to give +8 volts at terminal 9 of TB1403, with the coder-indicator turned OFF (in the Type AN/GRN-9C Beacon, no equivalent adjustment is provided). All klystron video grid drive adjustments will subsequently be made using R1470 in the Type AN/GRN-9A and -9B Beacons, and using R1723 in the Type AN/GRN-9C Beacon.

I Klystron Aging Procedure: When dual reference symbols are used, the first symbol refers to Type AN/GRN-9A and -9B Beacons; the second symbol refers to the Type AN/GRN-9C Beacon.

1. At distribution panel throw main switch for beacon being worked on, to OFF position.

2. Set the High Voltage switch on the High Voltage Power Supply to OFF.

3. Disconnect the RF drive at the input BNC jack on the klystron first cavity.

4. Set KLYSTRON BEAM VOLTAGE switch (S1006) to LOW position.

5. Reduce the video grid drive voltage to zero by turning potentiometer R1470/R1723 located on the Frequency-Multiplier-Oscillator video chassis, completely counterclockwise.

   NOTE: BEFORE PROCEEDING FURTHER, MAKE SURE HIGH VOLTAGE SWITCH ON THE HIGH VOLTAGE POWER SUPPLY IS OFF AND THAT HIGH VOLTAGE CAPACITOR IS DISCHARGED.

6. Connect multimeter between klystron grid and cathode, at exposed terminals. Set multimeter to appropriate range to read approximately 125VDC negative on grid with reference to cathode.

7. Energize the beacon at TMC and/or distribution panel.

8. Reading from klystron grid to cathode should be -125VDC. If it is not, adjust R1382/R1211, on bias supply chassis of Amplifier-Modulator, for -125 volts. NOTE: This adjustment is accessible only with the Amplifier-Modulator drawer open. To adjust, proceed as follows: Remove power, disconnect multimeter leads, open drawer, adjust control, re-close drawer, reconnect multimeter, restore power and check voltage. Repeat until correct bias reading is obtained.

9. Remove power and disconnect multimeter.

10. Restore power and operate the klystron filament only for 15 minutes.

11. Set High Voltage switch on the High Voltage Power Supply to ON and apply reduced high voltage (approximately 7000 volts from Step 4 above) for 15 minutes.

12. Adjust VIDEO DRIVE control R1470/R1723 until 10 ma. of beam current is indicated on the beam current meter, located on the front panel of the Amplifier-Modulator.

13. Every 5 minutes, advance R1470/R1723 clockwise to provide incremental increase of 10 ma. until 50 ma. of beam current is reached. Operate at 50 ma. for 5 minutes.

14. Set the High Voltage switch to OFF, turn R1470/R1723 completely counterclockwise.

15. Set KLYSTRON BEAM VOLTAGE switch (S1006) to NORMAL position.

16. Set High Voltage switch to ON, and adjust R1470/R1723 until 60 ma. of beam current is reached.

17. Every 5 minutes, advance R1470/R1723 clockwise to provide incremental increase of 10 ma. until 90 ma. is reached. Operate at 90 ma. for 5 minutes.

18. Reduce the video grid drive voltage to zero by adjusting R1470/R1723 to completely counterclockwise position.

19. Set High Voltage switch to OFF.

20. Reconnect the RF drive at the input BNC jack on klystron first cavity.

21. The klystron is now properly aged and ready to be placed in service.

II Transmitter Output Circuit Tuning Procedure:

NOTES:

a. When installing a klystron or making a frequency change, the three (3) cavities of the klystron should be pretuned mechanically (cold tuned) to the approximate operating frequency in accordance with the tuning chart supplied by the tube manufacturer. This should be done while the klystron is out of the equipment to permit access to the three (3) adjusting nuts on each cavity. The procedure is as follows:

1. Refer to the special tuning chart provided with each klystron. This chart shows three curves, one for each of the cavities, INPUT, MIDDLE and OUTPUT. The transmitter frequency will be found on the horizontal scale of the chart, and the spacing, in thousandths of an inch, between the inside surface of the flanges, on the vertical scale of the chart.

2. Locate the assigned transmitter frequency on the curve and record the proper spacing for each of the cavities.

3. As necessary, adjust each of the cavities to the recorded settings, making use of the wrench provided with the beacon, and an inside vernier or micrometer calipers. It is very important that the flanges be kept parallel with each other. This is accomplished by not turning any one nut more than a full turn before turning the other nuts the same amount.

b. If the klystron is being energized for the first time, or has not been energized during the past three months, it must be aged according to the procedure detailed above.

c. To perform several of the steps listed in the following tuning procedure it is necessary to detect the RF carrier signal and observe the detected pulse on an oscilloscope. To provide an impedance match and thus preserve the pulse shape, the patch cable from the beacon test jacks to the oscilloscope must be terminated in a low impedance at the oscilloscope end. To provide this termination, connect the UG-274/U Tee connector to the oscilloscope end of the patch cable, and connect the MX-554/U termination to the Tee connector. This termination must be used when observing waveforms from the beacon directional couplers.

d. Before tuning the transmitter output circuits, the carrier frequency generating chain in the Frequency-Multiplier-Oscillator drawer must be tuned as directed in the appropriate TACAN beacon instruction book.

e. When tuning Type AN/GRN-9A or -9B TACAN beacons for the first time, or when making a large change in output frequency, use tuning curves furnished with the beacon spectrum filter cavities to preset them. Remove the tuning screw covers and adjust the tuning knob for each cavity until the tuning screw is set to the dimension determined from the tuning curve.

III Tuning Procedure: The proper tuning procedure for the Type SAL-89 Klystron involves three basic requirements which must be satisfied in sequence, in order to prevent damage to the klystron output connector and associated components from high transmission line voltage and RF arcing. These are:

Step A. Create a matched RF transmission line while operating at reduced klystron output power level.

Step B. Apply rated klystron output power to this matched line by tuning the klystron to deliver maximum power.

Step C. WITHOUT RETUNING THE KLYSTRON OUTPUT CAVITY, adjust the double slug tuner, filter cavities (cavity), klystron input and middle cavities for best pulse shape and spectrum, consistent with maximum antenna power.

IV Procedure for Type AN/GRN-9A and -9B TACAN Beacons:

Step A.

1. MAKE SURE HIGH VOLTAGE SWITCH ON THE HIGH VOLTAGE POWER SUPPLY IS OFF AND THAT HIGH VOLTAGE CAPACITOR IS DISCHARGED.

2. Reduce the video grid drive to zero by adjusting potentiometer R1470 completely counterclockwise.

3. Energize beacon at TMC and/or distribution panel.

4. Open access door at cathode end of klystron and check with multimeter across grid and cathode connections for -125VDC bias on klystron. If correct value is not obtained, proceed as in Step 8 of the aging procedure, above.

5. Close klystron cathode compartment access door.

6. Set High Voltage switch to ON.

7. Adjust R1470 to provide beam current of 30 ma.

8. Disconnect the RF drive at the input BNC jack of the klystron first cavity, and connect it to the termaline resistor (Item 8), using adapter (Item 9) as necessary. With FMO tuning meter switched to the KLYSTRON INPUT INCIDENT position, tune the final amplifier of the RF exciter for maximum meter indication. Re-connect RF drive to klystron first cavity, switch tuning meter to KLYSTRON INPUT REFLECTED position, and adjust klystron input cavity tuning for minimum meter indication.

9. Connect oscilloscope to klystron middle cavity jack and adjust middle cavity for maximum oscilloscope indication.

10. Connect oscilloscope to KLYSTRON OUTPUT INCIDENT jack and adjust output cavity of the klystron, and the double slug tuner, for maximum oscilloscope indication.

11. Connect oscilloscope to KLYSTRON OUTPUT REFLECTED jack, and tune first (front) spectrum filter cavity for a minimum at the center of the pulse.

12. With oscilloscope connected as in Step 11, tune second (rear) spectrum filter cavity for minimum reflected signal.

13. Repeat Steps 11 and 12 until there is an absolute minimum of energy in the center of the pulse displayed on the oscilloscope.

Step B.

14. Check, and if necessary adjust, the shape of the grid drive voltage to that recommended by the manufacturer. Connect oscilloscope directly to KLYSTRON OUTPUT INCIDENT jack and adjust VIDEO DRIVE control R1470 for maximum power output obtainable without limiting, which can be observed as a flattening of the pulse. (Do not operate with a pulse which appears to be saturating at the peak.)

15. Repeat Step 8.

16. Connect oscilloscope to KLYSTRON OUTPUT INCIDENT jack, and adjust middle cavity for maximum oscilloscope indication. Simultaneously observe the pulse at the middle cavity jack taking care to maintain a smooth pulse at that point in the interest of good spectrum. The middle cavity will now be slightly detuned to the high frequency side.

17. Klystron output cavity and the double slug tuner final adjustment.

    a. At TACAN facilities equipped with the model RTC-1 TMC equipment apply the complete procedure of EFI, TACAN-15.
    b. At TACAN facilities equipped with the Military type test and monitor equipment alternately adjust the output cavity of the klystron and the double slug tuner for maximum oscilloscope indication at the KLYSTRON OUTPUT INCIDENT jack.

NOTE: AFTER THIS ADJUSTMENT, THE OUTPUT CAVITY OF THE KLYSTRON MUST NOT BE RETUNED OR DAMAGE TO THE KLYSTRON MAY RESULT.

Step C.

18. Connect oscilloscope to ANTENNA INCIDENT jack. Touch up tuning of spectrum filter cavities and make minor adjustments to the double slug tuner and the klystron input and middle cavities for maximum power* into antenna, consistent with best pulse shape for good spectrum. Further pulse shape improvement can often be obtained by repeating Step 14.

V Procedure for Type AN/GRN-9C TACAN Beacons:

Step A.

1. MAKE SURE HIGH VOLTAGE SWITCH ON THE HIGH VOLTAGE POWER SUPPLY IS OFF AND THAT HIGH VOLTAGE CAPACITOR IS DISCHARGED.

2. Reduce the video grid drive to zero by adjusting R1723 completely counterclockwise.

3. Set WIDTH control (R1718) completely counterclockwise (minimum) and RF DRIVE control (R1776) one half turn from the fully counterclockwise position.

4. Energize beacon at TMC and/or distribution panel.

5. Open access door at cathode end of klystron and check with multimeter across grid and cathode connections for -125VDC bias on klystron. If correct value is not obtained, proceed as in Step 8 of the aging procedure, above.

6. Close klystron cathode compartment access door.

7. Set high voltage switch to ON.

8. Adjust VIDEO DRIVE control (R1723) to provide beam current of 30 ma.

9. Disconnect the RF drive at the input BNC jack of the klystron first cavity, and connect it to the Termaline resistor (Item 8) using adapter (Item 9) as necessary. With the FMO tuning meter switched to the KLYSTRON INPUT INCIDENT position, tune the final amplifier of the RF exciter for maximum meter indication.

Re-connect RF drive to klystron first cavity, switch tuning meter to KLYSTRON INPUT REFLECTED position, and adjust klystron input cavity tuning for minimum meter indication.

10. Connect oscilloscope to klystron middle cavity jack and adjust middle cavity for maximum oscilloscope indication, maintaining a reasonably smooth waveform.

11. Connect oscilloscope to KLYSTRON OUTPUT INCIDENT jack and adjust output cavity of the klystron, and the double slug tuner (Z1201), for maximum oscilloscope indication. Tune double slug tuner carefully to simultaneously produce maximum pulse amplitude and minimum pulse width.

12. Connect oscilloscope to ANTENNA INCIDENT jack and tune spectrum filter cavity for maximum signal. Adjust carefully to position which gives maximum peak power with minimum pulse width.

Step B.

13. Connect oscilloscope to KLYSTRON OUTPUT INCIDENT jack. Adjust the VIDEO DRIVE control (R1723) and RF DRIVE control (R1776) for maximum power output. NOTE: Do not adjust to the point where limiting (flattening) or excessive widening of the pulse occurs.

14. Repeat Step 9.

15. Connect oscilloscope to KLYSTRON OUTPUT INCIDENT jack and adjust the middle cavity for maximum oscilloscope indication. Simultaneously observe the pulse at the middle cavity jack, taking care to maintain a smooth pulse at that point in the interest of good spectrum. The middle cavity will now be slightly detuned to the high frequency side.

16. Klystron output cavity and double slug tuner final adjustment.

    a. At facilities equipped with the model RTC-1 TMC equipment apply the complete procedure of EFI, TACAN-15.
    b. At TACAN facilities equipped with the Military type test and monitor equipment, alternately adjust the output cavity of the klystron, and the double slug tuner, for maximum signal and minimum pulse width observed at the KLYSTRON OUTPUT INCIDENT jack.

NOTE: AFTER THIS ADJUSTMENT, THE OUTPUT CAVITY OF THE KLYSTRON MUST NOT BE RETUNED OR DAMAGE TO THE KLYSTRON MAY RESULT.

Step C.

17. Connect oscilloscope to ANTENNA INCIDENT jack. Touch up tuning of spectrum filter cavity and make minor adjustments to the double slug tuner and the klystron input and middle cavities for maximum power* into antenna, consistent with best pulse shape for spectrum.

    Make necessary adjustments to the VIDEO DRIVE control (R1723) and/or RF DRIVE control (R1776) to improve pulse shape (hence spectrum). Further pulse shape improvement can frequently be obtained by repeating Step 13.

18. Adjust WIDTH control (R1718) clockwise if additional width is desired.

* Improper adjustment of the input and middle cavities can result in hum modulation of the transponder RF envelope as seen at the ANTENNA INCIDENT jack and may cause azimuth monitoring instability. This final adjustment should be made for minimum hum modulation on the peak of the pulse train as observed using an expanded vertical scope presentation with the horizontal sweep time adjusted to provide for one cycle covering the period from one north reference burst to the next successive north reference burst.

FAA-R-1265b
Attachment 3
January 7, 1963

REDUCED POWER APPLICATION

In addition to the requirements of the specification proper at the rated design and application parameters, this tube shall also operate normally meeting all performance requirements and not exceeding any of the ratings specified, under continuous operation at reduced output power levels. For this application, the following changes shall be made in the specification terminology:

RATINGS

Change e_g from "365 $\pm$ 55" to "240 $\pm$ 40."

Change p_o from "11.5" to "7.0."

Change du from "2.5" to "1.68."

Change P_i from '1840 max' to '1000 max.'

SPECIFIC INFORMATION

Production Tests

Anode current: Change e_g from "365" to "240"; change "4.8" to read "3.7."

Power output: Change e_g from "365 $\pm$ 55" to "240 $\pm$ 40"; change "11.5" to read "7.0." Change P_i from '1840 max' to '1000 max.'

Life Tests

Life Test: Change P_i from "1840" to "1000"; change e_g from "365 $\pm$ 55" to "240 $\pm$ 40."

Life Test End Point: Change "10.5" to read "6.5."

NOTE 2

i: Change the second sentence to read as follows: Operate at 60 ma for five minutes.

NOTE 10

b: Change "3783" to read "2800."

NOTE 14

Change "1840" to read "1000"; change "365 ± 55" to read "240 ± 40."

NOTE 16

In the first paragraph, change "365 ± 55" to read "240 ± 40" and change "11.5" to read "7.0."

b: Change the first sentence to begin as follows: "When the specified beam current (see Figure 6 for shape) has been applied and the tube..."

i: Change "11.5" to read "7.0."

FAA-R-1265b
AMENDMENT 1
February 19, 1963

FEDERAL AVIATION AGENCY

TECHNICAL SPECIFICATION

for

Three Cavity Pulsed Amplifier Klystron, Control Grid Modulated

Specification FAA-R-1265b dated January 7, 1963, detailing the requirements for a three cavity pulsed amplifier klystron, control grid modulated shall be changed as noted herein.

FAA-R-1265b

SPECIFIC INFORMATION

Production Tests

Cutoff Voltage: Change the symbol "I_c" to "I_b."

FIGURE 1

Change the maximum width of the pinch-off from 1 1/32" to 1 3/8".

FIGURE 3

Change the maximum dimension from the center of the tube to the extremity of the pinch-off from 4" to 4 1/4".

ATTACHMENT 1

BILL OR MATERIAL

Change this title to read "BILL OF MATERIAL."

Change the drawing numbers for the Moulded Hair Inner Pack from "SK-A-50672-1b" and "SK-A-50672-2b" to "SK-A-50671-1b" and "SK-A-50671-2b" respectively. Change the drawing number for the Metal Shipping Container from "SK-A-50671b" to "SK-A-50672b."